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## **Determinants of uptake and maintenance of active commuting to school**

**Elaine M. Murtagh Martin Dempster Marie H. Murphy**

**Department of Arts Education and Physical Education, Mary Immaculate College University of Limerick, Ireland**

**School of Psychology, Queen's University Belfast, Northern Ireland, UK**

**Sport and Exercise Science Research Institute, University of Ulster, Northern Ireland, UK**

### **Abstract**

The objective was to identify determinants of uptake and maintenance of active school travel (AST) over 4 years in children aged 9 at baseline. Data from wave 1 (n=8502) and 2 (n=7479) of the Growing Up in Ireland study were analysed. At 9- and 13-years 25% and 20% engaged in AST. Children were more likely to maintain or take-up AST if they lived in an urban area. Change in distance to school influenced both maintenance and adoption of AST, with a negative impact seen for increased distance between 9 and 13 years and a positive impact seen for decreased distance. Some factors which predict uptake and maintenance of AST are modifiable and can inform intervention development.

Keywords: Physical activity; active travel; school; commute; child; determinant

### **Highlights**

- Determinants of uptake and maintenance of active commuting to school were examined.
- The majority of children passively commuted to school at 9 (75%) and 13 years (80%).
- The associations between predictor variables were generally weak.
- Maintenance of active travel was less likely to occur when distance to school increased
- Taking up active travel is most likely to occur when distance to school decreases
- Urban residence was weakly associated with maintaining and taking up active travel
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## Introduction

In the past 3-4 decades motorised transport has become a predominant mode of transport for children and adolescents travelling to and home from school in many developed countries (Gordon-Larsen et al., 2005) including Ireland (Nelson et al., 2008, Author, 2011). The association between active travel to school and health has been established with children who actively commute having higher levels of physical activity (Cooper et al., 2003, Author, 2011), a healthier body composition (Lubans et al., 2011) and increased cardiovascular fitness compared with children who use motorised transport methods (Davison et al 2008). At a time where the low level of physical activity among children has become a public health concern – increased attention has been given to the role of active travel as a means of helping children reach recommended levels of physical activity (Cooper et al 2005). Indeed active transport has been promoted the '7 best investments that work for physical activity' (Global Advocacy for Physical Activity (GAPA) the Advocacy Council of the International Society for Physical Activity and Health (ISPAH), 2012) (GAPA 2012). A number of countries have tried to reverse the trend towards motorised transport through interventions designed to encourage children to walk or cycle some or all of the school journey (Garrard, 2009). Understanding the determinants of active commuting to school is important to the design of such interventions. Although a few studies have attempted to identify these determinants there have been no investigations of the predictors of active commuting to school in Irish schoolchildren.

Decisions on active or passive transport to school are likely to be influenced by myriad of factors at the policy, neighbourhood, and parent/family levels (Sirard and Slater 2008). Although several plausible models have attempted to provide conceptual frameworks for understanding active commuting behaviour in children and young adults (Sirard and Slater, 2008, McMillan, 2005, Panter et al., 2008) these have been developed largely from evidence from cross-sectional studies, therefore whether each variable lead to or results from children's active commuting is unclear (Davison et al., 2008). Longitudinal studies of multiple levels of influence on changes in young people's active commuting are required to examine the causal pathways of influence to inform programmes and policies seeking to promote active transport (Hume et al., 2009, McMillan, 2005).

The transition from primary to post-primary school is associated with a decrease in physical activity levels (Dumith et al., 2011) although little is known about how active transport to school contributes to the changes in physical activity noted during this transition. During primary school, children are deeply embedded in their family contexts, and so behaviours, such as active commuting are strongly influenced by their parents' attitudes, values and beliefs (Pont et al., 2009). With the transition to second level education increased autonomy could increase the potential for young adults to choose active transport to and from school. However the choice of mode of travel may be influenced by changes in other factors such as journey time/distances (Nelson et al., 2008, D'Haese et al., 2011), uniform/fashion (shoes) or the requirement to transport books or sports kit to and from school. To date few longitudinal studies have examined the change in commuting behaviour in the transition between primary and second level education. Therefore the present study examines variables associated with active commuting within each layer of the bio-ecological model to determine the predictors of maintenance and uptake of active commuting over 4 years in a sample of children at age 9 and 13 years.

## Methods

This paper involved analysis of data collected as part of the Child Cohort of *Growing Up in Ireland, The National Longitudinal Study of Children*. Technical reports on the design, instrumentation and procedures of *Growing Up in Ireland* have been published previously (Murray et al., 2010). In brief, the Child Cohort of the *Growing Up in Ireland* study is a nationally representative sample of 8500 children and their families. Children born between 1 November 1997 and 31 October 1998 were the sample for interview at nine years of age, with data collection taking place between August 2007 and May 2008 (Murray et al., 2010). The sample design was based on a two-stage selection process: a representative sample of 910 schools participated in the study – from the national total of 3,200 primary schools. The sample of children and their families was then randomly generated from within those schools. The sample frame consisted of all 9-year olds registered in primary schools in the Republic of Ireland (n=55,105). Data for 8568 children were available for analysis. A 2<sup>nd</sup> wave of data collection took place when the children were 13 years of age, with interviews conducted between August 2011 and February 2012 for 7400 participants (Department of Children and Youth Affairs, 2012). Ethical approval was obtained from a dedicated Research Ethics Committee established by the Department of Health and written informed consent was required from parents.

The Conceptual Framework for the Growing up in Ireland study is guided by Bronfenbrenner's 1979 bio-ecological model of child development, implying that development outcomes are seen as the result of an interplay between a large number of factors including the biology of the child, their immediate environment such as home, family and school, and wider influences such as the community and society (Greene et al., 2010). The study focuses on a broad range of child outcomes across three domains (1) physical health and development, (2) social/emotional/behavioural wellbeing, and (3) educational achievement and intellectual capacity (Greene et al., 2010). These outcomes were assessed in a home interview of both primary and secondary caregivers using computer-assisted personal interviewing (CAPI) and a self-completion questionnaire. Where applicable, questionnaires were also sent to non-resident parents and centre/home-based carers for self-completion.

For wave 1 a response rate of 82% was achieved at the school level and at the level of the household (i.e. eligible child selected within the school) a total of 57% of children and their families consented to participate in the study (Williams et al., 2009). The data were reweighted by adjusting the distribution of the sample to known population figures on the number and characteristics of children and their families from the 2006 Census of Population (Office of the Minister for Children and Youth Affairs, 2010)

## Measures

At both wave 1 and wave 2 parents were asked in a home interview to report how their child usually travels to school. There were six response categories: (1) walks, (2) by public transport, (3) school bus/coach, (4) by car, (5) rides a bicycle, (6) other. Walking or cycling was classified as active commuting. Using public transport, travelling by the school bus/coach or car were classified as passive commuting. The 'other' category was excluded from analyses as it could not be classified as passive or active.

Potential predictor variables were included if they were previously shown to be associated with active commuting to school in either cross-sectional or longitudinal studies (see appendix 1). As the *Growing Up in Ireland* study is guided by Bronfenbrenner's 1979 bio-ecological model, variables associated with active commuting within each layer of influence were selected. In total 20 variables were included in the analysis. These included four individual-level variables (gender, BMI, hard exercise, light exercise), five family-level variables (older sibling, household class, household income, single parent, parent education), two school-level (enrolment size, distance to school) and nine neighborhood-level variables (urban:rural status and 8 variables related to parental perceptions of neighborhood safety). Data on gender of the study child was collected from the Primary Caregiver. Information on perceptions of child physical activity level, neighborhood safety, distance to school, parent education, occupation of parents, and single parent status were gathered from the Primary Caregiver Main Questionnaire. Presence of older siblings was identified in the Child Sensitive Questionnaire at wave 1. The interviewer took anthropometric measurements of the child and adult respondents. Height was recorded to the nearest millimetre using a Leicester portable height measure and weight was recorded to the nearest kilogram using a SECA 761 flat mechanical scales (Murray et al., 2010). BMI classification of the study child was derived from this measured data using the IOTF cut-off points (Cole et al., 2000). Detailed description of the instruments used, including reliability and validity of measures, have been reported separately (Murray et al., 2010). The wording of each question is available online from the *Growing Up in Ireland* website ([www.growingup.ie](http://www.growingup.ie)).

#### *Data analysis*

Participants were classified into the following four groups: (1) maintained active commuting, (2) took up active commuting, (3) dropped out from active commuting, (4) maintained passive commuting.

The associations between changes over time in mode of commuting (active and passive) and the hypothesised predictor variables were examined using chi-square and Cramer's V. The outcome variable was a single variable representing all four groups of changes in commuting. The predictor variables represented change over time. Cramer's V converts the chi-square statistic into an effect size measure, thus providing an indication of the size of the association. It ranges from 0 to 1, with values closer to 1 indicating a stronger association. Where Cramer's V values were 0.1 or greater, the associations between these variables and change in commuting practice (maintaining AST, taking up AST and dropping out from AST) were examined further by generating Cramer's V values for the association between the predictor variable and each of categories in the outcome variable (that included active commuting) separately.....

## Results

Characteristics of the sample are shown in Table 1. At 9-years of age 75% of children travelled to school using passive travel modes. At 13 years 66% of students (n=4912) maintained passive commuting modes, 14% (n=1035) switched from active to passive commuting, 11% (n=809) maintained active commuting, and 9% (n=662) took up active commuting. Overall, at 13 years 80.2% of the sample travelled to school using passive modes. As can be seen from Table 1, there was very little change over time in urban/rural location of the child.

**Table 1: Characteristics of participants at 9 and 13 years**

	<b>Baseline (n=8502) Mean (SD)</b>	<b>Follow-up (n=7479) Mean (SD)</b>
Age	9.0 (0.1)	13.0 (0.1)
BMI	17.8 (3.0)	20.6 (3.6)
	<b>Percentage</b>	<b>Percentage</b>
Gender		
• Female	51.4	51.1
• Male	48.6	48.9
Parents with 3 <sup>rd</sup> level education	50.9	56.5
Region		
• Urban	45.5	46.5
• Rural	54.5	53.5
Mode of commuting to school		
• Walk	23.8	17.8
• Public transport	0.8	7.9
• School bus	12.1	22.6
• Car	62.1	49.7
• Bicycle	1.3	2.0

The associations between change in mode of commuting and the change in the selected predictor variables are shown in Table 2. Of the 20 determinants of active commuting included in the analysis; thirteen demonstrated a significant association with change in mode of commuting. The strongest associations were seen for urban:rural status (at baseline) and change in distance from school.

**Table 2: Association between change in mode of commuting and change in a range of variables over time (Cramer's V)**

Change Variable	Change in commuting
<b><i>Individual child</i></b>	
Sex/gender (at baseline)	0.040**
Child's BMI	0.018
Child's physical activity level (hard exercise)	0.022
Child's physical activity level (light exercise)	0.054***
<b><i>Family</i></b>	
Older sibling	0.018
Household class	0.026
Household income	<0.001
Living with 1 parent	0.042***
Parent education	0.029
<b><i>School</i></b>	
School enrolment size	0.039**
Distance to school	0.291***
<b><i>Neighbourhood / Community</i></b>	
Parental perceptions of neighbourhood safety	
• Rubbish/litter	0.040**
• Homes & gardens in bad condition	0.028
• Vandalism	0.038**
• People drunk /taking drugs	0.074***
• Safe to walk alone after dark	0.035**
• Safe for children to play outside during the day	0.051***
• Safe play spaces	0.054***
• Too much traffic (at baseline)	0.105***
Urban: rural status (at baseline)	0.328***

\*p < .05; \*\*p < .01; \*\*\*p < .001

Table 3 shows the associations between selected variables and maintaining, taking up and dropping out from AST. This includes school- and neighbourhood/community-level variables. Living in an urban area was significantly associated with maintaining, taking up and dropping out from AST, with the strongest association seen for maintaining AST. While parental perceptions of too much traffic in the neighbourhood was significantly associated with both maintaining and taking up active travel to school, the associations were weak. There was no significant association between too much traffic in the neighbourhood and

dropping out from active travel. A significant association was noted for change in distance to school. Specifically, maintenance of active travel is less likely to occur for those whose distance to school increased between age 9 and 13 years. Taking up active travel is most likely to occur for children whose distance to school decreases, while dropping out from active travel is most likely to occur for children whose distance to school increases.

**Table 3: Associations between predictor variables and maintaining, taking up and dropping out from active travel**

Variable	Maintaining AT	Taking up AT	Dropping out from AST
Change in distance to school	0.124***	0.305***	0.277***
Too much traffic (at baseline)	0.083***	0.04**	0.021
Urban: rural status (at baseline)	0.220***	0.147***	0.112***

\*p < .05; \*\*p < .01; \*\*\*p < .001





## Discussion

These findings add to the limited evidence base on longitudinal determinants of active commuting to school. Mode of school transport at 9 years persisted for the majority of the sample, with only 23% of children changing their commuting practices by the time they were 13 years old. Change in distance to school influenced both maintenance and adoption of AST, with a negative impact seen for increased distance between 9 and 13 years and a positive impact seen for decreased distance. Children were more likely to both maintain and take up active travel if they lived in an urban area. This paper is the first to report longitudinal data from an Irish context and also adds to the limited evidence base of longitudinal studies internationally therefore making a valuable contribution to our understanding of active travel behaviour for children over time. Insight into the predictors of uptake and maintenance of active commuting may help to guide public health policy and the development of interventions seeking to modify commuting behaviour.

Consistent with previous longitudinal studies (Chillón et al., 2015, Panter et al., 2013, Larouche et al., 2013), distance emerged as an important predictor of active commuting. In the present study, change in distance to school between 9 and 13 years influenced maintenance and adoption of AST, with a negative impact seen for increased distance and a positive impact seen for decreased distance. An association between active travel and distance a school is located from a child's home has also been demonstrated in cross-sectional research (Pont et al., 2009, Panter et al., 2008). Less than 1 mile has been described as a "reasonable and safe" walking distance from school (Falb et al., 2007) and a U.S. study found that living within a mile of school made it over three times more likely that a child would walk to school rather than be driven (McMillan, 2007). The findings of the present study lend support to the conclusions of a population-based longitudinal cohort study in the UK where 1421m, or just under 1 mile, was identified as the threshold distance that best discriminated walkers from passive commuters in 10 year old children (Chillón et al., 2015). Planners and policy makers should consider the available catchment area when deciding on the location of new schools so that the maximum number of children will be living within the ideal distance for active commuting to take place. The change in distance to school between 9 and 13 years observed in the present study is likely to reflect the transition to post-primary school which may be sited further from the child's home. These findings have important implications for identifying the most appropriate interventions to increase active commuting in those children who live a large distance from school. For example, the use of "drop off spots" – designated places where parents can drop their children to walk the remaining route to school (D'Haese et al., 2011) – are emerging as a promising strategy (Vanwolleghem et al., 2014, Eyler et al., 2008) .

Urban:rural location was a predictor of maintenance and uptake of active commuting between aged 9 and 13 years with those who lived in an urban area more likely to maintain and take up active travel than their rural counterparts. While findings regarding urban:rural location from cross-sectional studies reported in a systematic review were equivocal (Pont et al., 2009), the importance of urban location on active commuting behaviour was demonstrated in a Canadian longitudinal study which followed children from aged 6 to 16 years (OR:3.66; Pabayo et al., 2011). Less infrastructure for walking and longer commuting routes in rural areas may explain why children are less likely to actively commute than those living in urban areas (Davison et al., 2008). Conversely, characteristics of urban locations such as greater street connectivity, intersection density and mixed land use compared to rural areas may increase opportunities to walk or cycle to school.

Though many argue that changes in urban form, such as increase block lengths, street widths and decreased presence of paths/sidewalks in communities have led to decreases in children travelling by foot or on bikes in urban areas (McMillan, 2005). The need for tailored strategies to promote active commuting for children rural areas is also supported by research which demonstrates that rural youth are at increased risk for obesity and physical inactivity (Yousefian et al., 2009).

Social environmental variables, such as favourable neighbourhood characteristics, have been reported as correlates of greater likelihood of active travel to school (Panter et al., 2010). Conversely, in the present study, parental perceptions of “too much traffic” at baseline demonstrated a weak association with maintenance and take up of active commuting. It has previously been shown in cross-sectional research that walking to school is higher in children attending schools in neighbourhoods with low traffic volume (Giles-Corti et al., 2011). In addition, parents who considered their children’s journey to be unsafe were mostly afraid of dangers from traffic and were significantly more likely to accompany their children to school (Bringolf-Isler et al., 2008). Interestingly there was no significant association between parental perceptions of too much traffic in the neighbourhood and dropping out from active travel between 9 and 13 years. Indicating that other variables, such as increased distance to school, are likely to have greater impact on whether a child continues active commuting as they age.

The proportion of children actively commuting to school at both time-points was relatively low (25% at age 9 and 20% at aged 13) compared to other European countries (McMinn et al., 2014). However these findings reflect Irish national statistics which report that 25% of all 5 – 12 year olds walk to school (Central Statistics Office, 2012). Rates of active commuting to school vary greatly across countries, which may be influenced by factors such as climate, built environment, topography, traffic regulations and cultural norms. For example, in the US 13% of children 5 to 14 years of age usually walk or cycle to school (National Center for Safe Routes to School, 2011). By contrast in Belgium this figure is 60% for 11-12 year olds (D’Haese et al., 2011). Evidence that interventions can be successful in improving active commuting rates is encouraging. These include promoting active commuting to school through education (McKee et al., 2007), provision of supports such as “walking school buses” (Mendoza et al., 2011) and changes to urban form such as pedestrian crossing improvements and construction of cycling paths (Staunton et al., 2003). In Ireland, the Active School Flag initiative ([www.activeschoolflag.ie](http://www.activeschoolflag.ie)) and the Green Schools initiative ([www.greenschoolsireland.org](http://www.greenschoolsireland.org)), known internationally as Eco-Schools, work with schools to increase the rate of walking and cycling to school. In particular the promotion of “park n stride” initiatives attempts to overcome the challenge of increased distance to school that were noted in the present study (National Transport Authority, 2011). This use of designated drop-off locations within walking distance of schools may also be an option for promoting active travel for children living in rural areas (Safe Routes to School National Partnership).

### *Limitations*

A number of limitations to this analysis should be noted. Firstly, the majority of participants maintained a passive mode of commuting over time. This means that only a small proportion of participants changed their mode of commuting, or remained active over time. Consequently, the 2<sup>nd</sup> phase of analysis focuses on a small subgroup of participants. Secondly, mode of transport to school was based upon parental recall and

may be open to recall bias. Thirdly, while the instruments used in the Growing Up in Ireland study have been described in detail (Murray et al., 2010) the reliability and validity of the measurement of mode of commuting has not been tested. Parents were asked to note how their child usually travelled to school. It is possible that children used both active and passive commuting throughout the week which was not catered for in the question responses offered. Lastly, the physical environment has been shown to be an important correlate of active travel, however the available variables in the Growing Up in Ireland dataset did not allow further examination of this influence.

### *Conclusions*

This study is the first longitudinal analysis of the patterns of active school transport in Irish children. Although active school transport levels are low in Ireland compared to European counterparts they remain consistent within individual young people. Active transport choices persist in the transition from primary to post-primary education with distance from home to school and urban location being among the key predictors of the establishment and maintenance active school travel behaviours. From a policy perspective, many of the determinants identified are modifiable and our findings can inform both the design of interventions and the siting of new schools so that active travel choices can be maximised.

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